# Ascom PLT Measurements in Winchester

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# Contents

# Summary

This project was designed to update Ofcom on the nature and extent of the unavoidable radio frequency leakage emissions that radiate from modern Power Line Telecommunications networks. Particular interests were the rate at which PLT leakage emission levels decay with distance from their source.

This report covers the first part of the project and is specific to the situation at Winchester where Scottish and Southern Energy plc were undertaking a full scale commercial trial of PLT using first generation Ascom APM-45 equipment.

Calibrated measurements of PLT leakage emissions were made at the Chaundler Rd Substation network in the Abbotts Barton area of Winchester during December 2003 and October / November 2004. This location is on the edge of the Winchester PLT deployment area and adjacent to a large open space facilitating field strength regression measurements out to 100 metres from the PLT network.

Using a low noise broadband loop antenna, it was found that emissions from the Chaundler Rd access PLT network, measured at 1, 3, 10, 30 & 100 metre distances, demonstrated a regression rate of approximately 20 dB per decade of distance (1/r).

Within Europe, PLT leakage emission limits are still under discussion but, for reference purposes, PLT emission levels at Winchester were compared with the existing German NB30 PLT limit.

With the Chaundler Rd sub-station modem set to operate at its maximum Power Spectral Density of -50dBm/Hz, emissions in the Ascom access PLT band, measured at 3 metres from the substation LV distributors, peaked at 50dBµV/m on 4.8 MHz. This level exceeds the German NB30 emission limit by up to 15 dB.

Another test, made by applying the Ascom in-house PLT frequencies to the access PLT network, but at 6dB less than full power, gave similar leakage emission levels of 50dBµV/m measured at 3 metres on 22.8 MHz.  This level, indicative of that likely to be found inside a PLT customer premises and inside adjacent premises, exceeds the German NB30 emission limit by up to 20dB.

## Section 1

# Background

Power Line Telecommunications (PLT), Power Line Communications (PLC) and Broadband *over* Power Line (BPL) are all terms used to refer to the process of delivering high frequency broadband data over existing electricity supply cables, on a secondary use basis. The generic term PLT will be used in this report.

PLT products are designed to provide broadband internet access using electricity distribution networks as a transmission medium. In concept, PLT has some similarities with ADSL in that it delivers high frequency broadband data using existing infrastructure cables on a secondary use basis.

Access PLT networks feature high frequency internet signals that are passed between an electricity sub-station and all the PLT customers connected to it. A typical 500 kVA substation can serve up to about 200 electricity users, situated within a 200 metre radius, with the potential PLT customer base being a small percentage of these. To serve these customers, each PLT enabled electricity sub-station must be connected to an ISP via a dedicated high capacity link.

In principle, PLT is in competition with ADSL and Cable although, in practice, the PLT market share in the UK is currently extremely small as there are only a few isolated commercial trial networks in operation. One reason for this is concern over leakage emission levels. Although efficient for their primary purpose, electricity supply cables are not designed, screened or balanced for high frequency use and in this application they produce significant leakage emissions. These emissions have the potential to interfere with the reception of radio communication services, including short wave broadcasts.

This potential for interference from PLT networks was first raised by RA during 1997 as a result of leakage emission measurements taken at the first UK trials of PLT, by United Utilities, in Manchester. The interference aspect of PLT has been widely debated in many discussion groups since. The PLT industry has participated in these discussions from the outset and responded to the interference issue by focussing on more efficient modulation techniques. These permit operation over a wider bandwidth with less power spectral density than some early PLT deployments. Other measures, such as the use of quasi-balanced signal coupling and the use of intermediate repeaters have also reduced leakage emission levels in some applications.

The PLT interference issue is contentious and remains under discussion within the EC and elsewhere. Various radiated emission limits have been proposed, either for system compliance or for the purposes of adjudication in cases of reported interference, but currently none can satisfy the dual objective of protecting radio reception whilst, at the same time, allowing PLT to operate in a commercially viable manner.

The advent of multi-carrier PLT signal architecture has lead to a comparatively recent development in which pre-defined frequency bands within the broadband PLT spectrum can be notched to lower the launch power spectral density. The notched frequency bands have significantly reduced leakage levels. This technique is being promoted by PLT manufacturers and operators as a useful mitigation measure in cases where nearby radio receivers are experiencing interference from PLT signal leakage even though the leakage levels may be within the currently proposed emission limits.

The first generation Ascom APM-45 equipment deployed at Winchester and the subject of this report, does not have a notching capability.

Section 2

# Introduction

## Scottish and Southern Energy's PLT Trials

Scottish and Southern Energy plc, a major UK power utility, is currently conducting several trials of access PLT products. Small scale trials are in place at Crieff and Campbeltown in Scotland with larger trials underway at Stonehaven in Scotland and at Winchester in England.

S&SE's promotional material for their PLT based broadband products can be found at:

http://www.hydro.co.uk/broadband/index.asp

and at

http://www.southern-electric.co.uk/broadband/

Some of these trials are receiving external support, including that from central government through the DTI broadband fund. More details can be found at:

http://www.ssetelecom.co.uk/news/index.asp

and at

http://www.scottish-enterprise.com/sedotcom_home/services tobusiness/broadband/broadband-news/power_line_trial.htm

## The Winchester PLT Network

The full-scale commercial trial of access PLT at Winchester, a town with a population of approximately 42,000, was established in late summer 2003. A significant number of Winchester's electricity substations have been PLT enabled for this trial using, first generation, Ascom PLT equipment. A news item on the subject can be found at:

http://www.ascom.com/plc/news_plc.htm?year=2003

Scottish and Southern stated that their Winchester trial was intended, primarily, to allow them to assess the commercial market for PLT when it is in competition with both ADSL and Cable, the other main sources of broadband provision in the town.

## Measurement Objectives

This work follows on from previous measurements of Ascom based PLT networks made by Ofcom/RA at S&SE's Maidenhead headquarters (**Ref. 1**)

And measurements made at Crieff and Campbeltown by teams from Baldock Radio Station. (**Refs. 2 & 3**)

The objectives of this work were set by the Radiocommunications Agency prior to its incorporation into Ofcom on 29 December 2003. They were:

**1.)** To measure the level of leakage emissions at defined distances from the Ascom PLT network.

*This information was required in order to establish a degree of correlation with the previous work and also to compare leakage emission levels with proposed emission limits.*

**2.)** To assess the rate at which PLT leakage emissions regress as the distance from the network to the measurement position is increased.

*This information is required to establish a reliable distance conversion factor based on real measurements rather than technical assumptions.*

**3.)** To undertake an in-depth study of PLT leakage emissions in and around a PLT customer premises and to assess their effect on short wave broadcast reception.

*Previous measurements in and around PLT customer premises have been limited by the degree of access and disruption it was reasonable to expect S&SE's PLT customers to live with.*

*To improve on this situation it was proposed that RA rent a suitably placed property in Winchester into which PLT equipment would be installed by S&SE. The property was then to be used for close-in PLT leakage emission measurements from the in-house PLT network.*

*It was further proposed that the BBC be invited to use the property to continue their previous work on the effect of PLT leakage emissions on both AM broadcast reception and reception of the new Digital Radio Mondiale services*. (**Ref. 4**)

*This aspect is addressed further in the second report of this series.*

Section 3

# Summary of findings

## PLT leakage emission levels

Within Europe, PLT emission limits are still under discussion but, for reference purposes, PLT emission levels at Winchester have been compared with the existing German NB30 PLT limit. (**ref. 5**)

With the Chaundler Rd sub-station modem set to operate at its full power setting of +8 dBm per GMSK carrier (a PSD of -50dBm/Hz) emissions in the access band, measured at 3 metres from the substation launch point, peaked at 50dBµV/m on 4.8 MHz. This level exceeds the NB30 emission limit by up to 15 dB.

Although not the way an Ascom access PLT system would be configured in practice, another test, made by applying the in-house frequencies to the access network, with a launch power of +2 dBm per carrier (a PSD of -56dBm/Hz) gave similar leakage emission levels of 50dBµV/m measured at 3 metres on 22.8 MHz. This level exceeds the NB30 emission limit by up to 20dB.

## PLT leakage level regression

The rate at which PLT leakage emissions reduce in level (regress) as the distance from the network is increased is an important factor in assessing the interference potential of PLT networks. The regression characteristic is also needed to reference emission levels, or limits, measured at one distance to those made at other distances.

Using a high sensitivity broadband loop antenna, it was found that emissions from the Chaundler Rd access network, measured at 1, 3, 10, 30 & 100 metre distances, demonstrated a regression rate of approximately 20 dB per decade of distance (1/r).

At the time of testing, the Chaundler Rd substation network had no active PLT customers so it was not possible to measure the regression from an in-house PLT network, although it is predicted that a (1/r) curve would also apply in this case.

# Section 4

# Test Notes

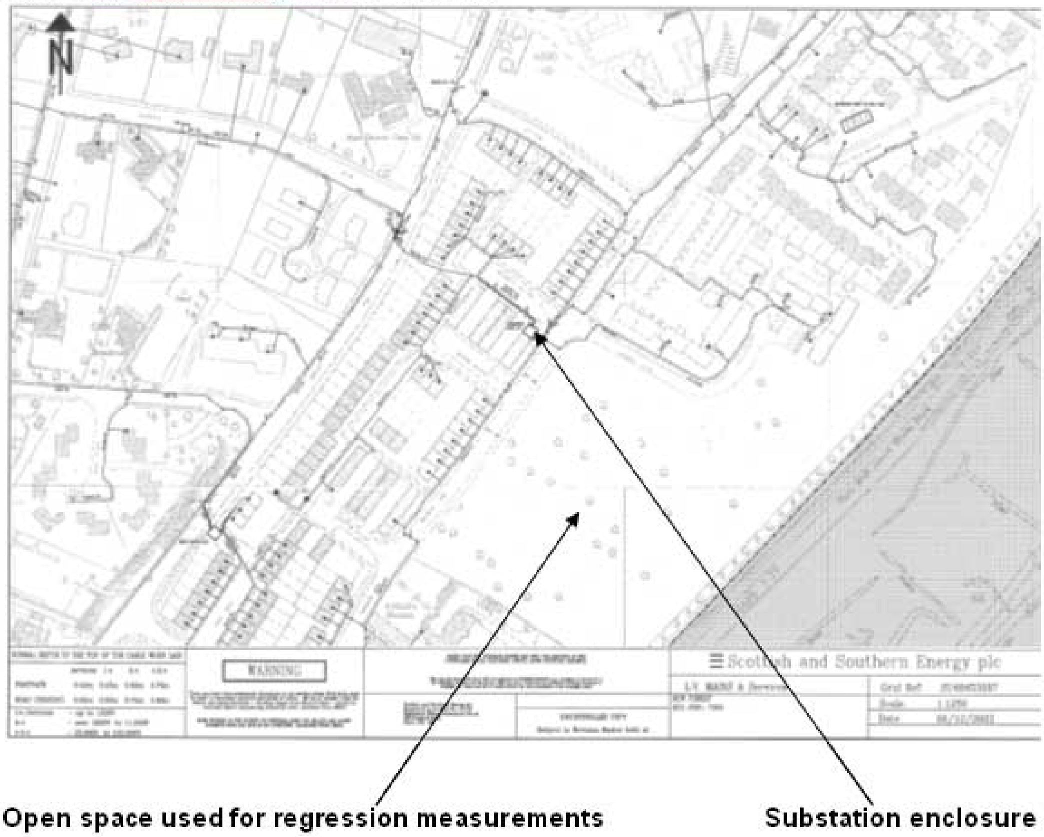
## Measurement Location

The most stringent requirement on the test location was the need to make leakage emission regression measurements at distances of up to 100 metres from a single PLT network but without encroaching on other, adjacent, PLT networks.

The approach taken was to seek a PLT enabled sub-station on the edge of the Winchester. The Chaundler Road Sub-Station, at (NGR) SU 485 309, has a large open space adjacent to it and was chosen as best meeting this requirement.

The map below was provided by S&SE and shows the substation and associated Low Voltage Electrical Distribution Network (LVEDN)

**Figure 1 Chaundler Road LVEDN Map**



## The Ascom PLT System

Ascom APM-45 PLT equipment transfers broadband data using 2 MHz wide GMSK carriers. Three GMSK carriers at 2.4, 4.8 and 8.4MHz are used for the access or ‘outdoor’ part of the network and three GMSK carriers at 19.8, 22.8 and 25.2MHz are used for the customer premises or ‘indoor’ network. Symmetrical, bulk data transfer rates of up to 4.5 Mbps are claimed.

The Ascom PLT system comprises:

> One APM-45o outdoor master unit installed at each PLT enabled electricity sub-station. This unit communicates over the outdoor Low Voltage Electricity Distribution Network (LVEDN) with all APM-45ap gateway units installed in PLT customer premises that form part of that sub-station’s electricity distribution network.
>
> One APM-45ap gateway unit (outdoor slave / indoor master) installed in each PLT customer premises to communicate over the in-house electricity wiring with a single APA-45i powerline adapter slave unit. The APA-45i powerline adapter is a PLT Modem that is connected to a single user’s computer via an Ethernet or USB port.

Other Ascom gateway units are available to cater for multiple users housed within a single customer premises. More details can be found at:

http://www.ascom.com/plc/products_plc/product_overview_plc.htm

To account for variations in PLT network attenuation, the operator (S&SE) has remote control of the output power level of the Ascom Master units.

The default power setting for the master units is +2 dBm per GMSK carrier, equivalent to a PSD of -56dBm/Hz.

Power is adjustable, in 6 dB steps, from -16 dBm per carrier to the full power condition of +8 dBm per carrier. This gives a PSD range, with all three GMSK carriers on, of -74 to -50dBm/Hz.

For reduced bandwidth applications, a single GMSK carrier can be operated at +14 dBm.

The power output of the slave units is dynamically controlled by the master units to achieve a satisfactory signal to noise ratio.

It is understood that S&SE’s normal practice is to operate the Ascom master units at their default setting of +2 dBm per carrier with the full power setting of +8 dBm being used if the default setting proves inadequate to deliver the required signal to noise ratio at any of the slave units.

If running the master units at full power does not result in satisfactory operation, repeaters can be used.

## The Chaundler Rd PLT enabled substation

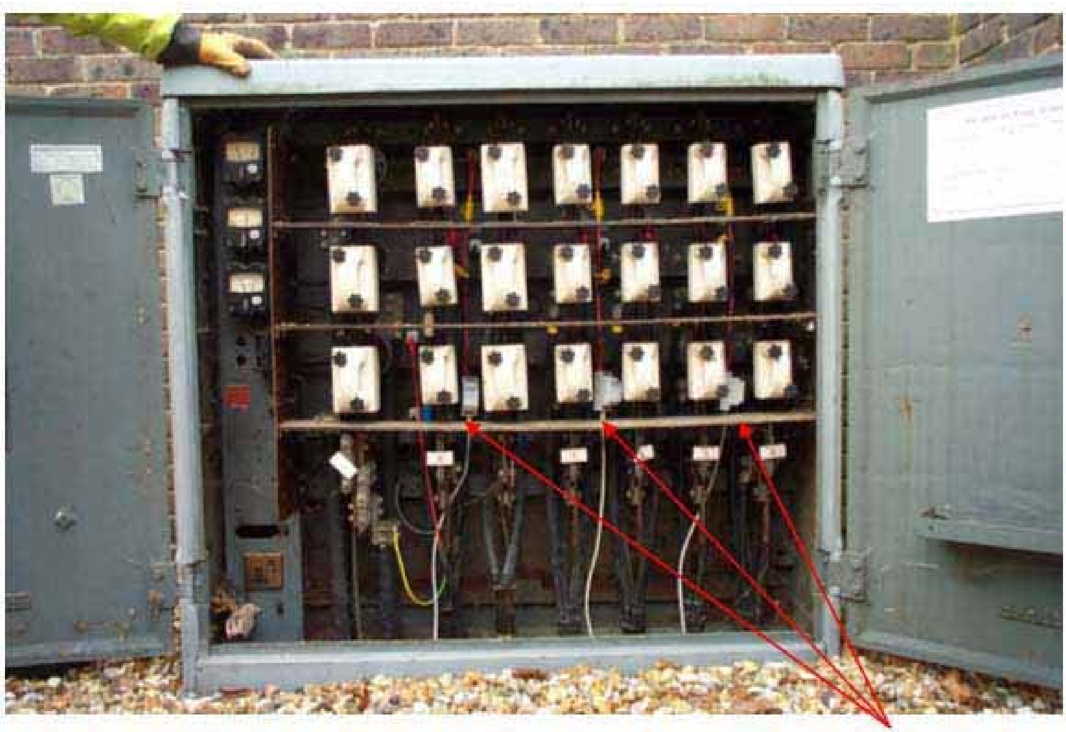
**Figure 2  PLT Equipment Cabinet**

The picture shows the PLT equipment cabinet within the substation enclosure.

The Ascom APM-45o unit is shown on the right with Ofcom's Shaffner SMZ11 current clamp in position beneath it to measure the PLT access spectrum. At this location, PLT backhaul is provided by SDSL with the line terminating unit shown on the left and the SDSL Modem in the centre.

Three output cables from the Ascom APM-45o unit run through an underground duct into the substation connection pillar where they attach to three Ascom SCD-F-A PLT couplers. The couplers are used to transfer the PLT signals on to the substation's low voltage bus bars for distribution throughout the local electricity network.

**Figure 3   Connection Pillar housing LV Bus Bars**



The three PLT cables from the APM-45o unit can be seen attached to the PLT couplers nestling between the fuses.  The PLT couplers each feed the Red and Yellow phases in a quasi-balanced configuration having no neutral or ground connection

## Test Equipment

All PLT leakage emission measurements were made using a Rohde & Schwarz HM525, low noise, broadband magnetic loop antenna together with a Rohde & Schwarz ESCS30 EMI measuring receiver. Both the antenna and receiver were battery powered to allow portability and to eliminate the possibility of ground loop currents adversely affecting the measurements.

With the bandwidth and detector settings used, this measuring system has a noise floor of approximately 10dBµV/m. This is up to 20 dB lower than can usually be achieved with measuring systems employing the standard 60cm loop antenna specified in CISPR 16.

The lower measuring system noise floor achieved was needed to explore the regression characteristic of the PLT leakage emissions at distances of up to 100 metres from the network.

Had the standard CISPR 60 cm loop antenna been used, most PLT leakage emissions would have been below the measuring system noise floor at distances beyond about 10 metres from their source thus preventing further regression analysis.

## PLT Network settings

The PLT network is a linear system so leakage emission levels track the launch power.

The launch power of the Ascom system has a control range of 24dB that is adjustable by the network operator in 6 dB steps. In normal use the launch power will either be set to its default value of +2dBm per carrier, a PSD of -56dBm/Hz or to its maximum power setting of +8dBm/Hz, a PSD of -50dBm/Hz.

The power setting in use was confirmed before each measurement.

## Presentation of the results

The measuring receiver was set to scan across the PLT carrier frequencies in 5 kHz increments and a measurement was recorded at each increment.

The large quantity of data collected was stored on floppy discs and read into a spreadsheet programme for subsequent analysis and production of the charts presented in this report.

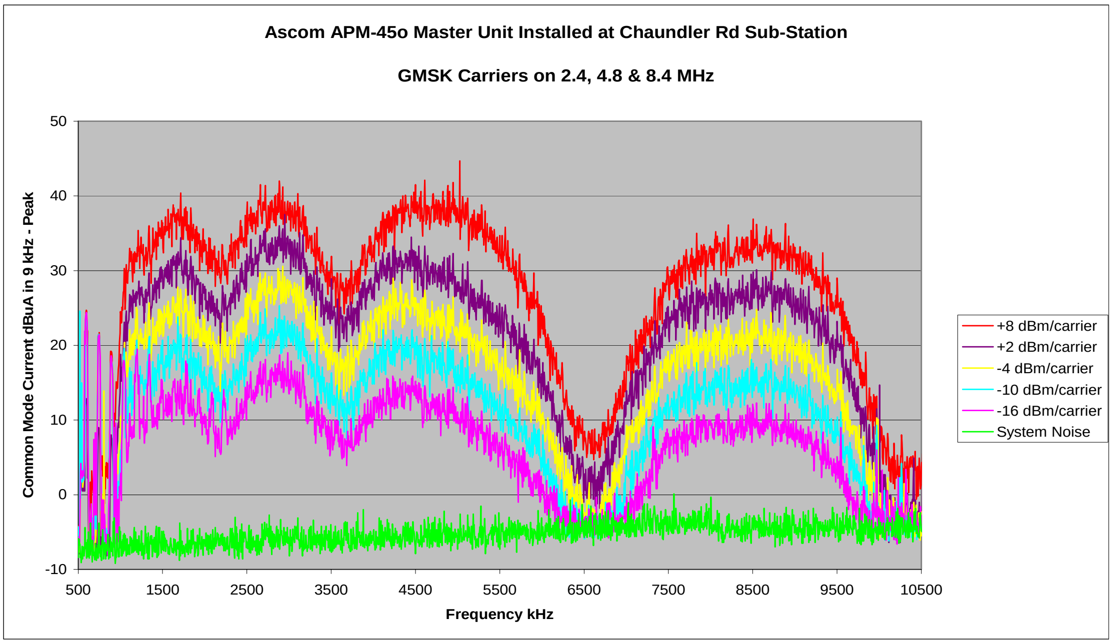
Section 5

# Measurement Results

## Ascom Access Spectrum - Conducted

The Ascom access PLT spectrum was plotted at the Chaundler Rd sub-station. Ascom APM-45o units have no readily accessible test points so the PLT spectrum was plotted by measuring the common mode current on the cables joining the APM-45o unit to the three Ascom SCD-F-A PLT couplers in the substation connection Pillar as shown in Fig. 2 The chart below shows the result of swept frequency measurements across the Ascom access frequency spectrum with the APM-45o unit set to each of its five different power settings.

**Figure 4 Access Frequency Common Mode Current**




The three, 2 MHz wide, GMSK carriers centred on 2.4, 4.8, and 8.4 MHz can be seen together with a 10dB null in the common mode current at 2.4 MHz. The null is believed to be a network resonance effect, probably due to the common mode impedance being high at this frequency.

## Ascom Access Spectrum - Radiated

Radiated measurements of the Ascom PLT access frequencies were made with the APM-45o unit set to operate at its maximum power output level of +8 dBm per GMSK carrier. (-50dBm/Hz)

It should be noted that, at the time of testing, there were no PLT customers using the network so the three GMSK carriers ran in continuous mode rather than in TDD mode as would have been the case if APM-45ap gateway units had been installed in customer premises.

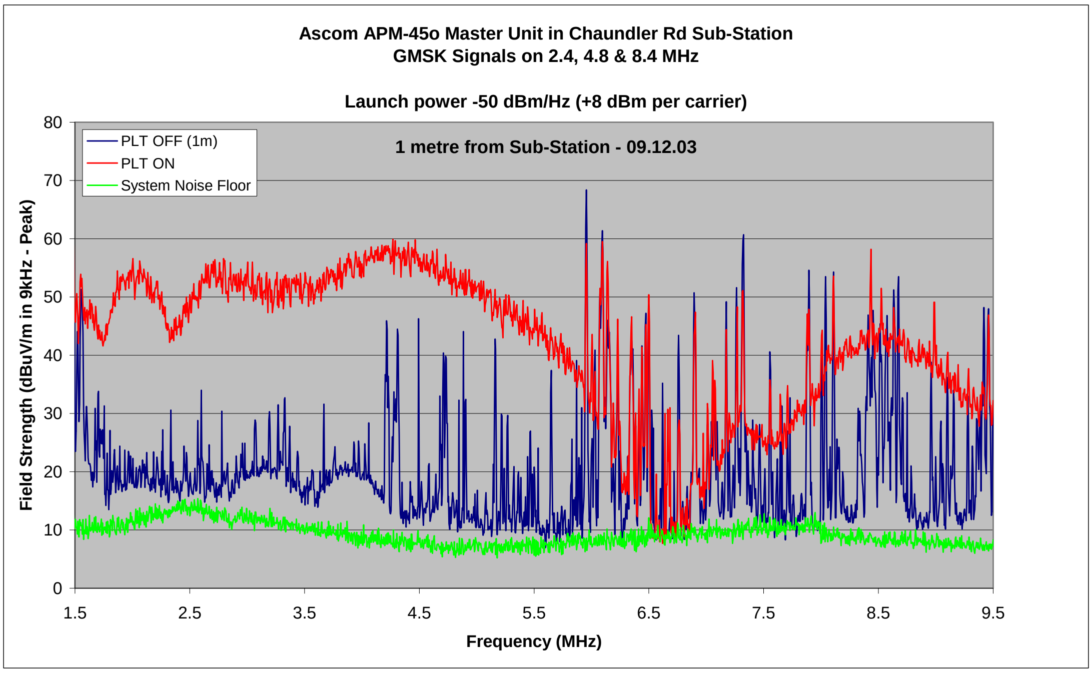
## Radiated measurements at 1 metre

The picture below shows the first 1 metre measuring position in with the HM 525 loop antenna placed directly over underground LVEDN distributors leaving the sub-station.

**Figure 5   1 Metre Measurement Position in Chaundler Road**

The chart below shows the radiated field at this position, approximately 1 metre from the underground LVEDN cables running beneath the antenna.

**Figure 6   1 metre leakage emission levels in Chaundler Road**



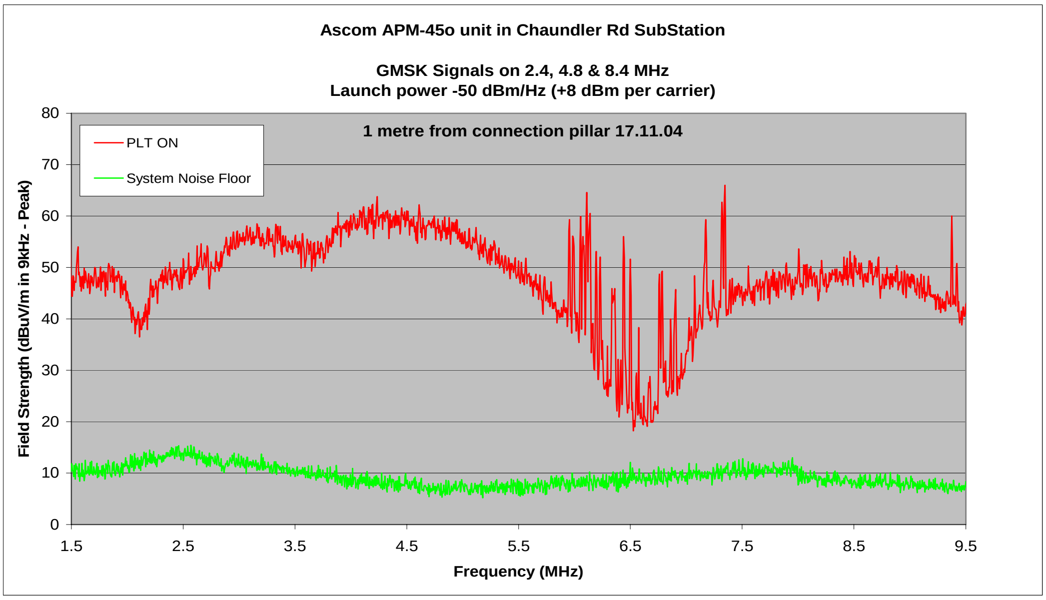
The blue trace shows the ambient noise and radio signals measured at this position with the Ascom APM-45o unit switched off.

The picture below shows the loop antenna placed 1 metre from the connection pillar within the Chaundler Rd sub-station enclosure.

**Figure 7   1 metre measuring position in Chaundler Road substation**

The chart below shows the radiated field at this position.

**Figure 8   1 metre leakage emission levels in Chaundler Road substation**




‘

PLT ‘off’ measurements were not taken at this position

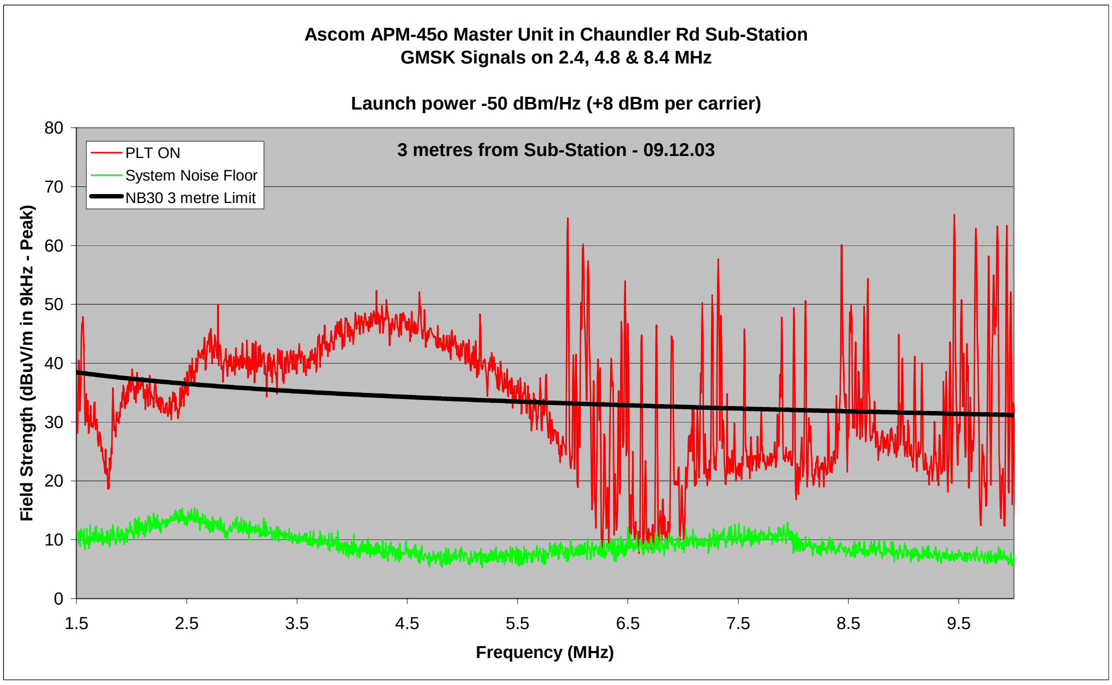
## Radiated measurements at 3 metres

The first 3 metre measuring position is shown below. The loop antenna was placed at approximately 3 metre equidistant spacing from two cables exiting the sub-station.

**Figure 9   3 metre measuring position in Chaundler Road**

The chart below shows the radiated field at this position.

**Figure 10   3 metre leakage emission levels in Chaundler Road**



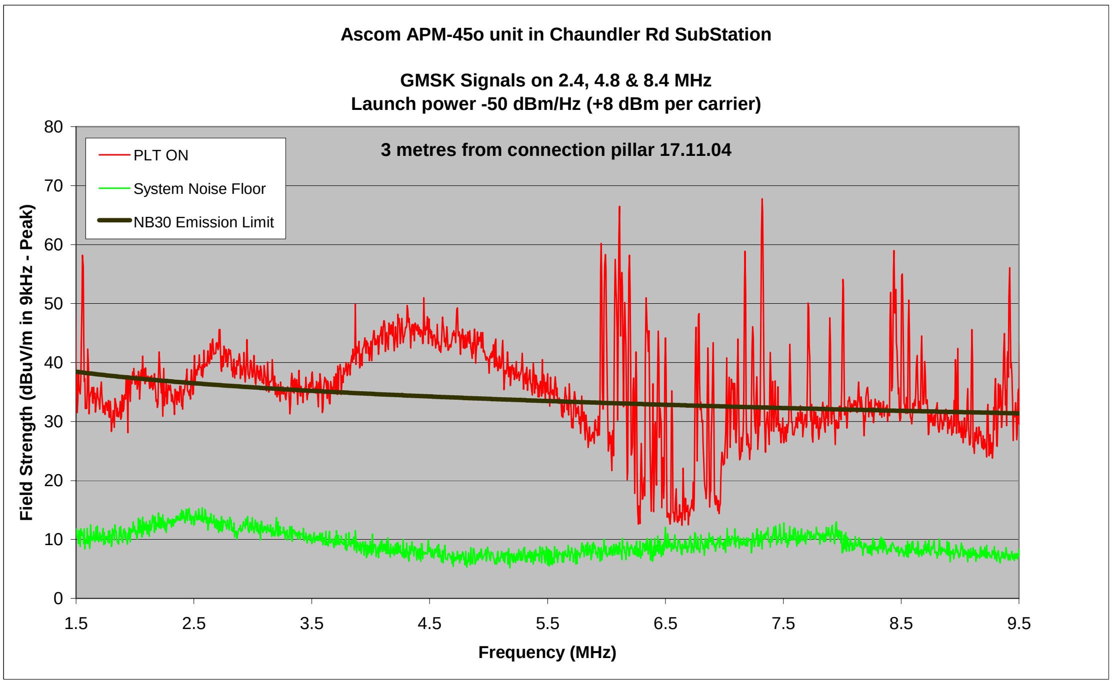

The German NB30 3 metre PLT limit, of 40-(8.8 log f), is not applicable in the UK but is shown here for comparison purposes.

The second 3 metre measuring position, at the other side of the substation is shown below.

**Figure 11 3 metre measuring position at the back of the substation**

The chart below shows the radiated field at this position.

**Figure 12 3 metre leakage emission levels at the back of the substation**

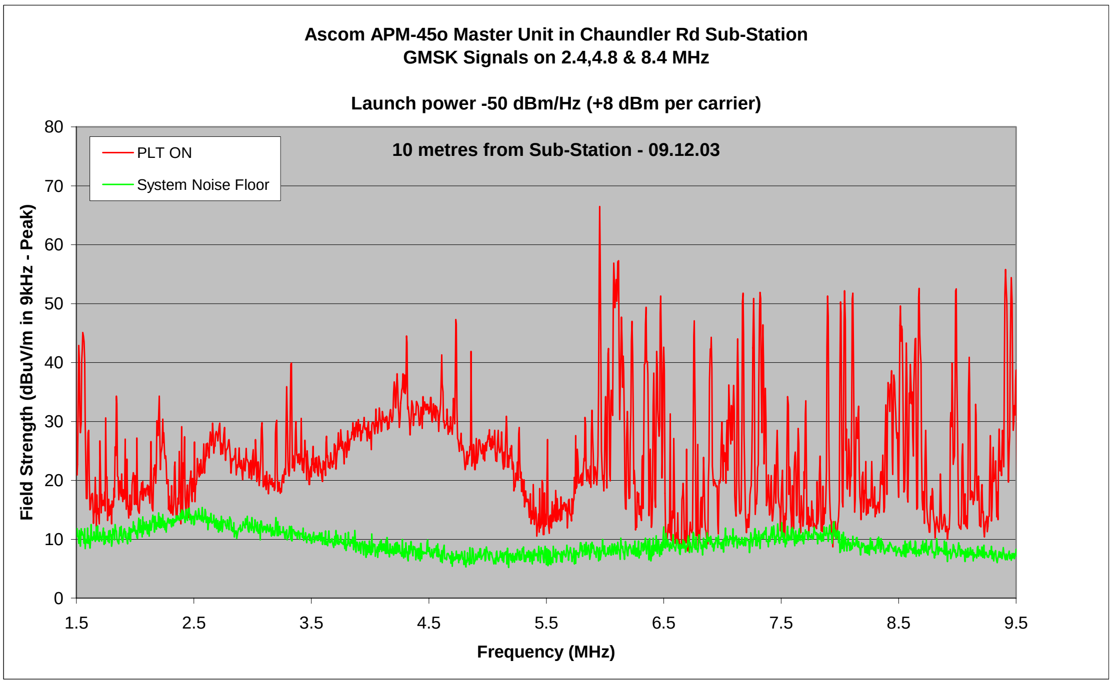



The German NB30 3 metre PLT limit, of 40-(8.8 log f), is not applicable in the UK but is shown here for comparison purposes.

## Radiated at 10 metres

**Figure 13. 10 metre measuring position in Chaundler Road**

**Figure 14 10 metre leakage emission levels in Chaundler Road**

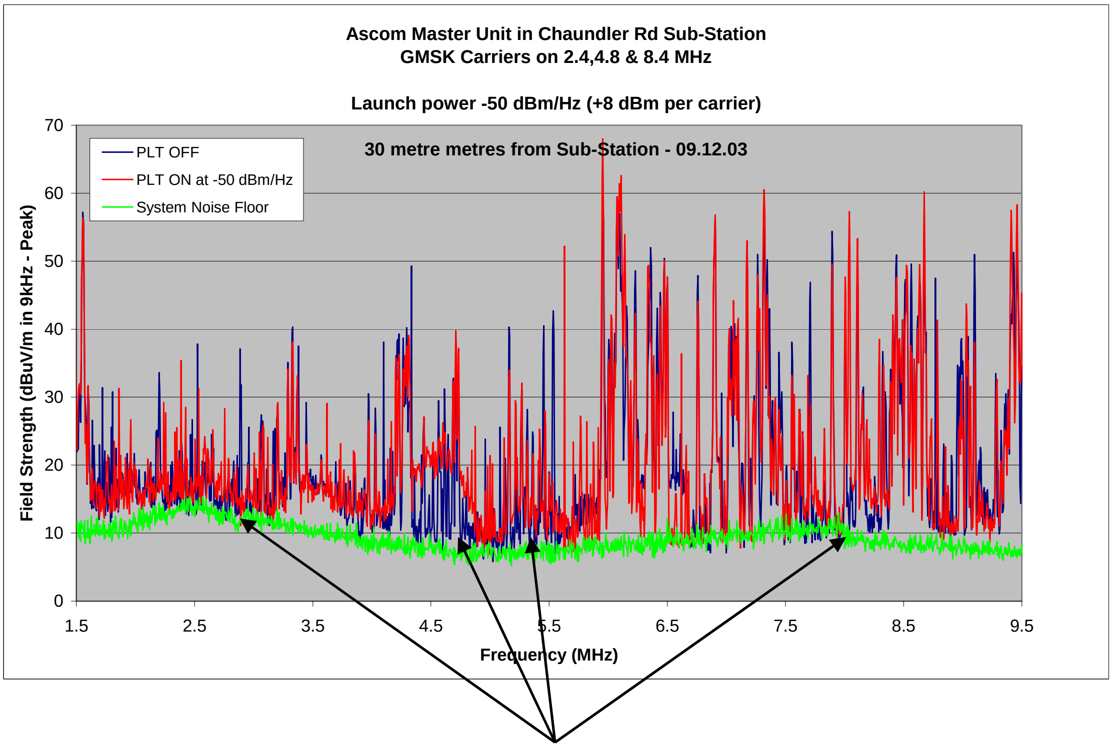



The ‘PLT off’ condition was not measured at this location.

## Radiated at 30 metres

**Figure 15 The 30 metre measuring position off Chaundler Road**

**Figure 16 30 metre leakage emission levels off Chaundler Road**

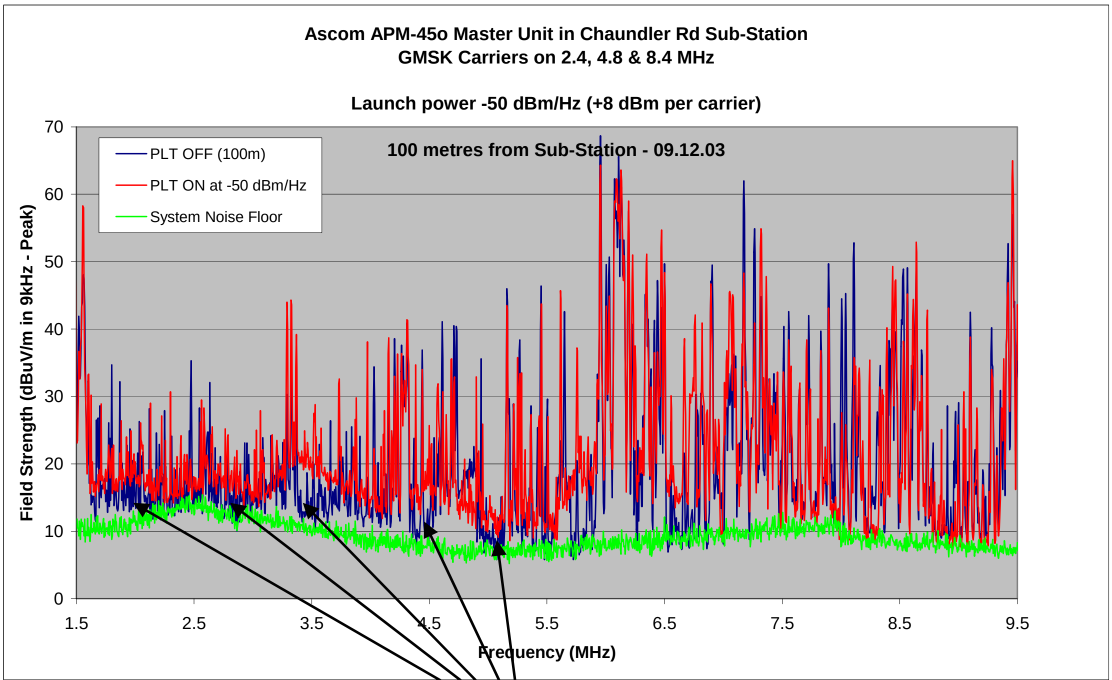



PLT emissions can be seen as a raised noise floor profile on the red 'PLT ON' trace

## Radiated at 100 metres

### Figure 17 The 100 metre measuring position off Chaundler Road

### Figure 18 100 metre leakage emission levels off Chaundler Road

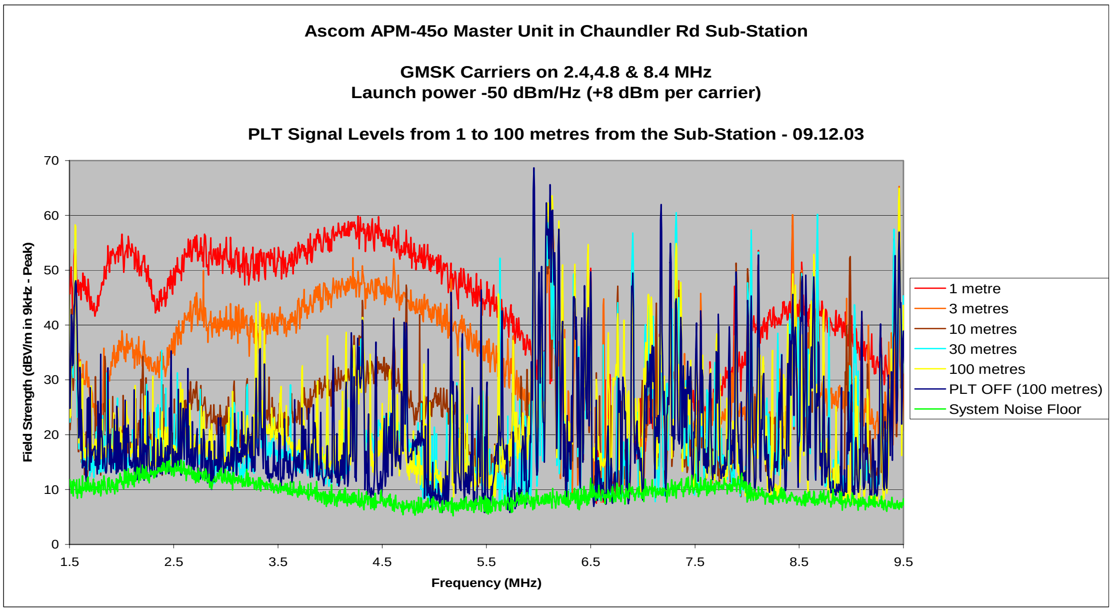



PLT leakage emissions can be seen as a raised noise floor profile on the red ‘ON’ trace

## Ascom Access Spectrum – Network Regression Characteristics

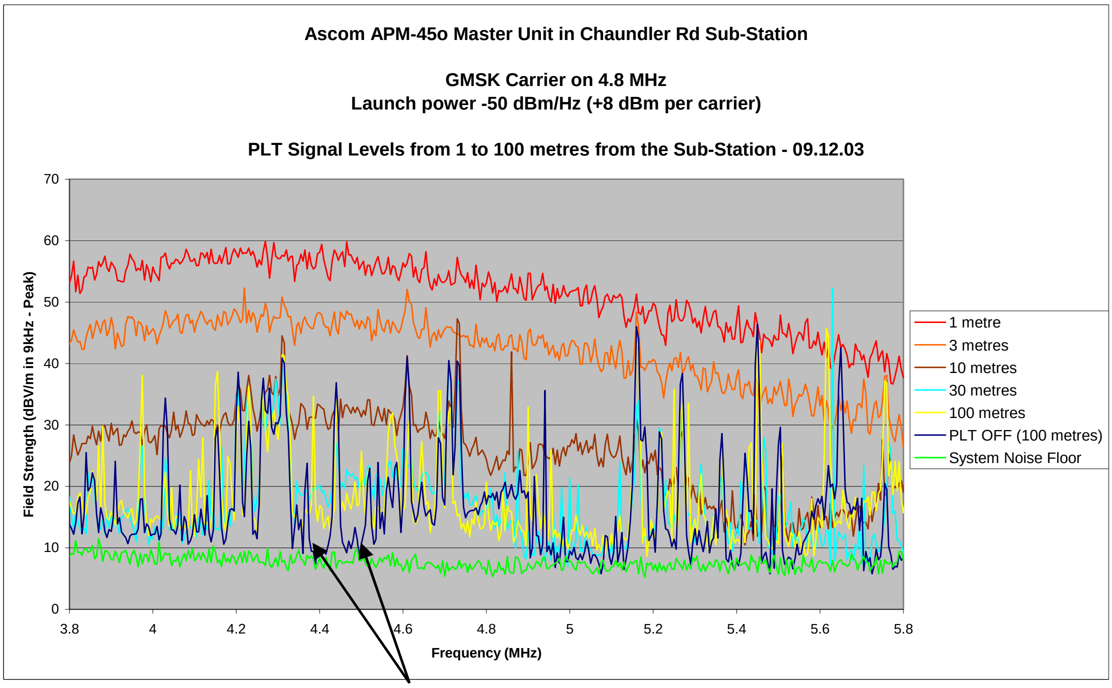
An initial view of the field strength regression characteristic was made by combining the 1 to 100 metre measurements on to the single chart shown below.

### Figure 19 1 to 100 metre leakage emissions from 1.5 to 9.5 MHz




This part of the frequency spectrum is very crowded with radio services. To facilitate analysis the chart has been expanded below.

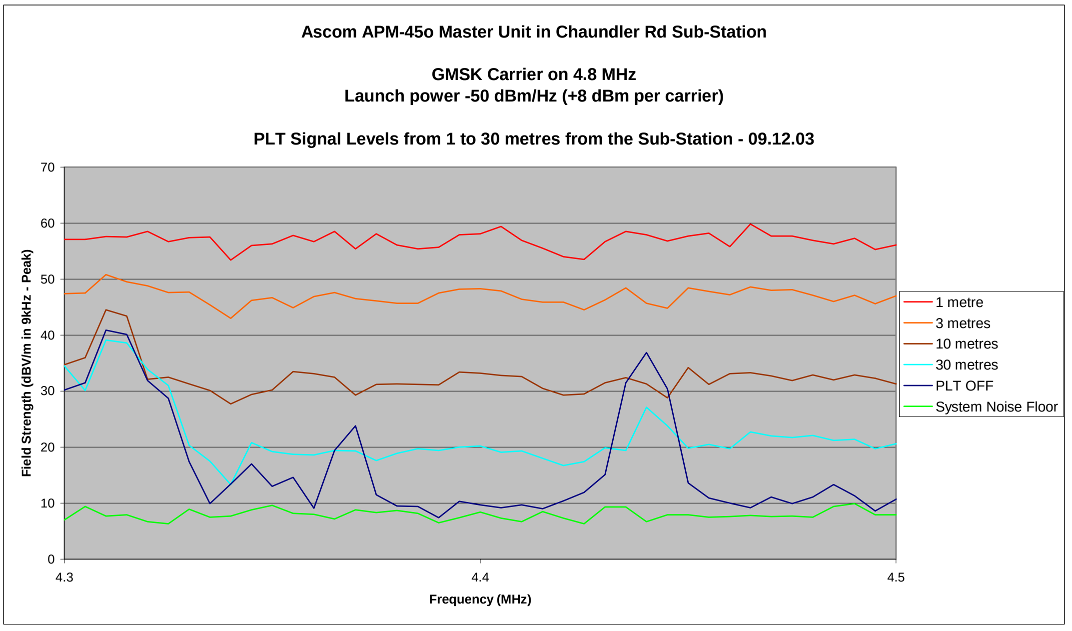
### Figure 20 1 to 100 metre leakage emissions at 4.8 MHz



This 4.8 MHz chart above can be further expanded to look into these two 'gaps' in the spectrum at 4.4 and 4.5 MHz that have no significant radio transmissions.

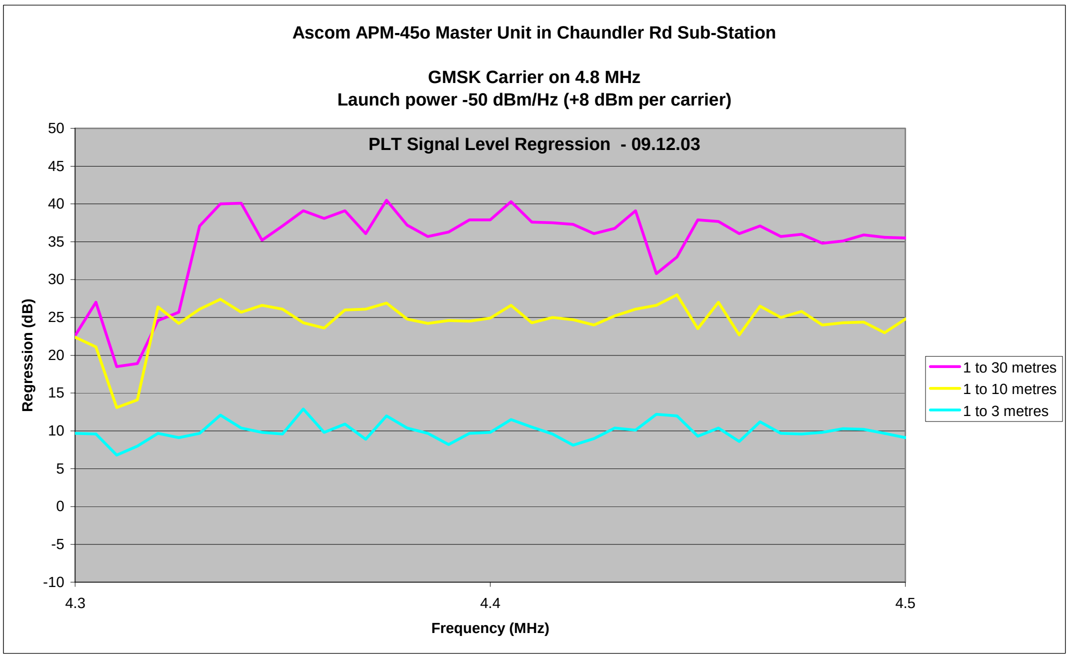
## Ascom Access Spectrum – Network Regression Characteristic - 4.5 MHz

### Figure 21 1 to 100 metre leakage emissions at 4.4 MHz




The 4.4 MHz spectrum shown above has been used to assess the regression characteristic from 1 metre to 30 metres. The result can be seen below.

### Figure 22 1 to 30 metre regression characteristic at 4.4 MHz




The approximate regression characteristic shown is:

| | |
|---|---|
| 1 to 3 metres | 20 dB/ decade (1/r) |
| 1 to 10 metres and 1 to 30 metres | 25 dB/decade (1/r^1.25) |

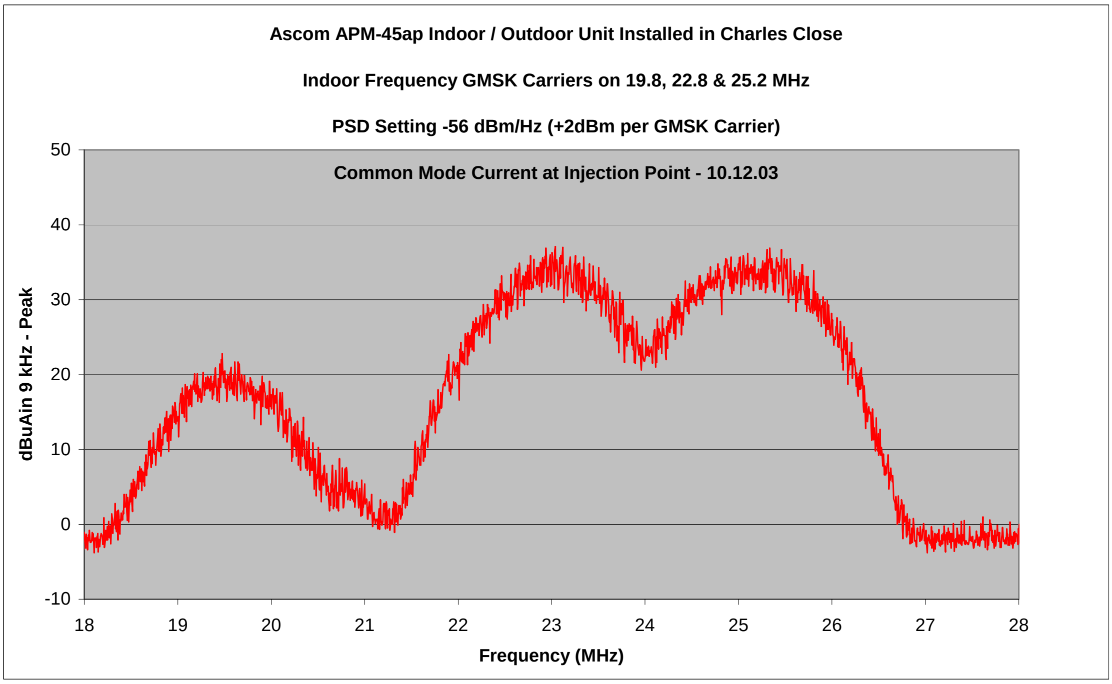
## Ascom APM-45ap Indoor Spectrum

An Ascom APM-45ap gateway unit is normally installed near the electricity meter in each PLT user premises. The unit functions as a slave in respect of the three 'outdoor' GMSK frequencies (2.4, 4.8 & 8.4 MHz) coming in from the APM-45o unit at the electricity sub-station. They frequency translate data to and from the three 'indoor' GMSK frequency bands (19.8, 22.8 & 25.2 MHz) where they act as a master to the APA-45i adapter (PLT modem) installed at the user's computer.

Unfortunately there were no PLT users within the Chaundler Rd sub-station network during the measurement period so an APA-45ap gateway unit was installed instead on the outdoor network using a single phase feeder that supplied a street lamppost in Charles close. The lamppost was disconnected from the feeder during the measurements. This arrangement was used both to measure the Ascom in-house frequency spectrum mask and also to get a further assessment of the access network regression characteristic.

The Ascom indoor PLT spectrum mask was obtained by using a current clamp on the output of the Ascom APM-45ap unit to measure the common mode current injected into the outdoor network.

**Figure 23 Common mode current into access network at in-house frequencies**




The three indoor GMSK carriers are continuous until they find and synchronise with, an indoor adapter.

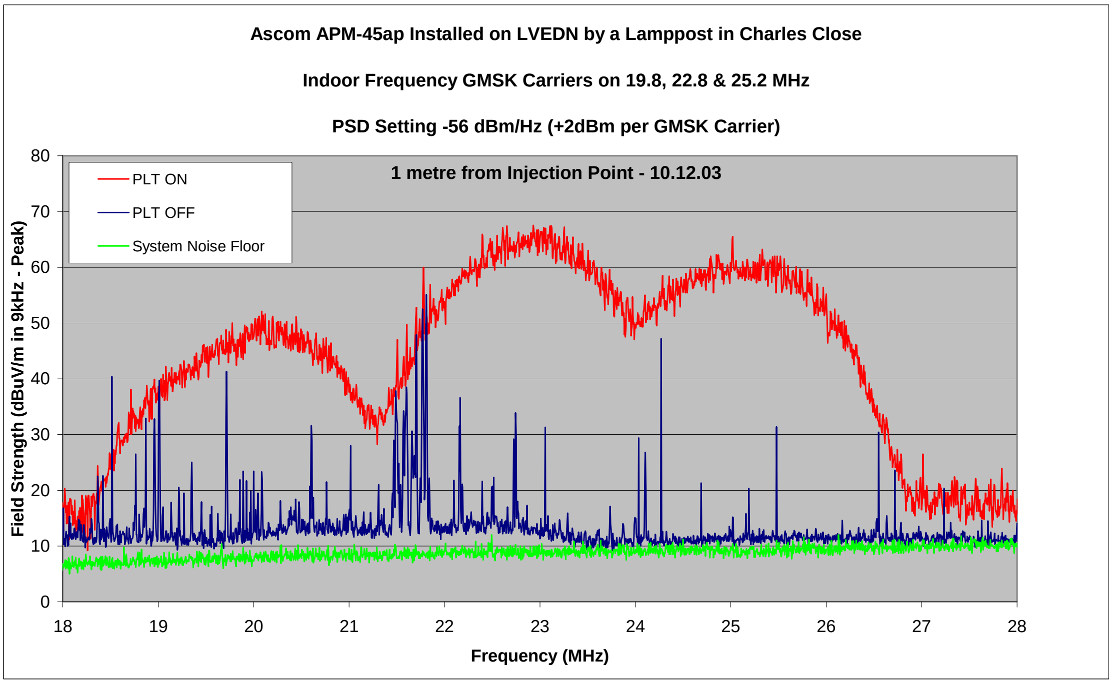
## Ascom Indoor Spectrum – Radiated

Radiated measurements of the Ascom in-house frequencies were made with the APM-45ap unit set to operate at its default power output level of +2dBm per GMSK carrier.

It should be noted that, at the time of testing the three GMSK carriers ran in continuous mode rather than in TDD mode because this was not an in-house network with an APA-45i indoor adapter to communicate with.

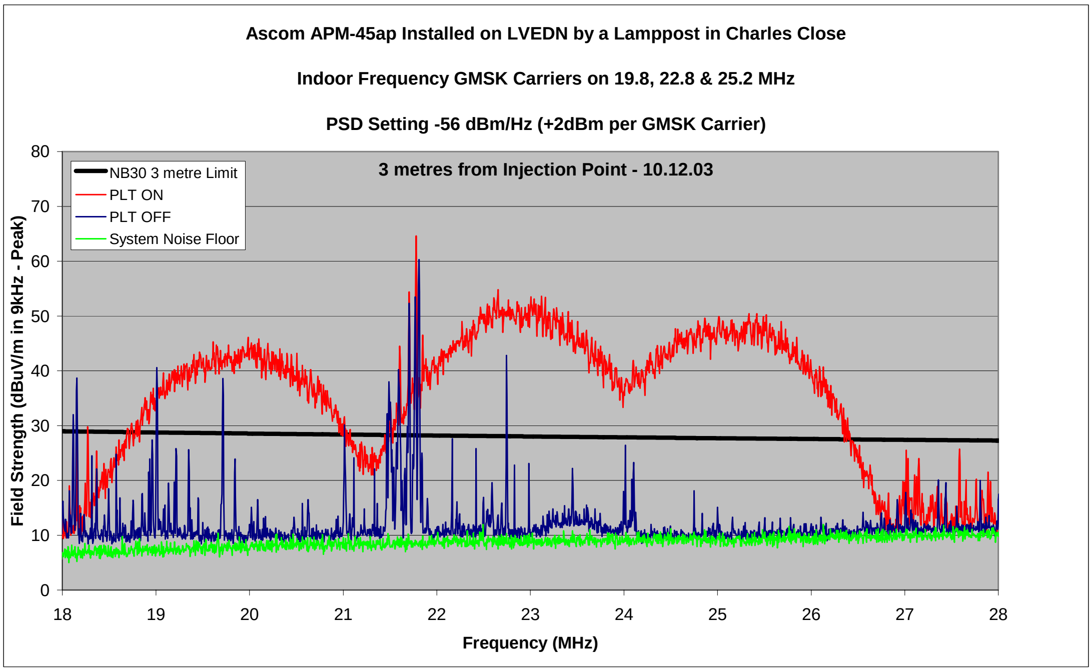
## Radiated at 1 metre

### Figure 24 1 metre leakage emission levels in Charles Close



## Radiated at 3 metres

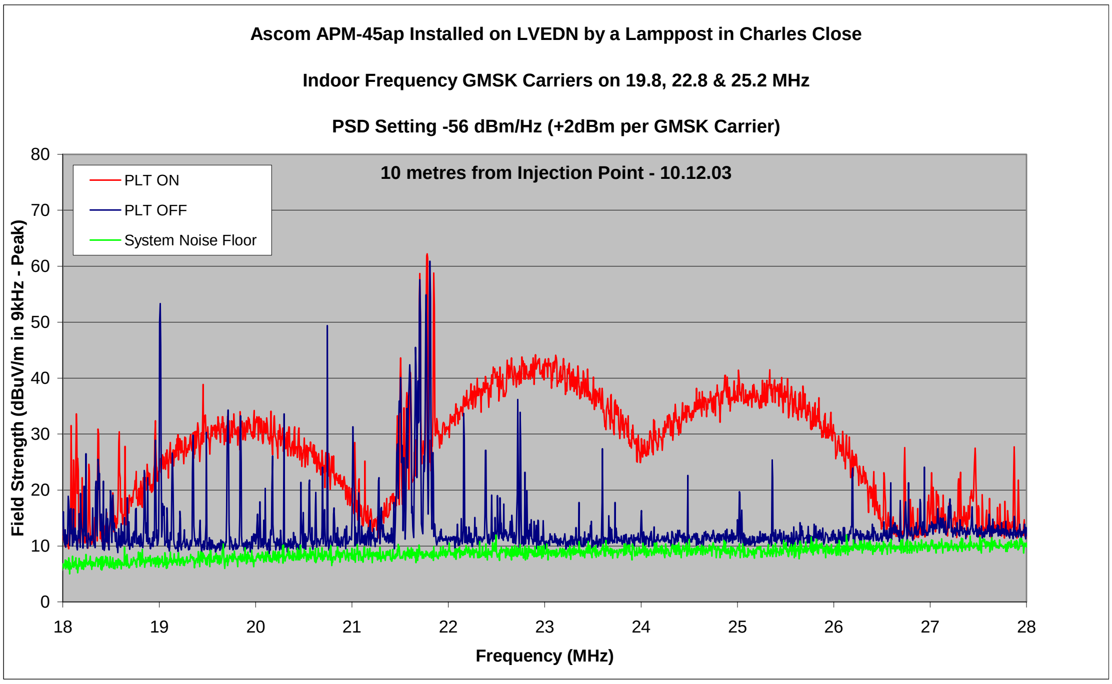
### Figure 25   3 metre leakage emission levels in Charles Close




The German NB30 3 metre PLT limit, of 40-(8.8 log f), is not applicable in the UK but is shown here for comparison purposes.

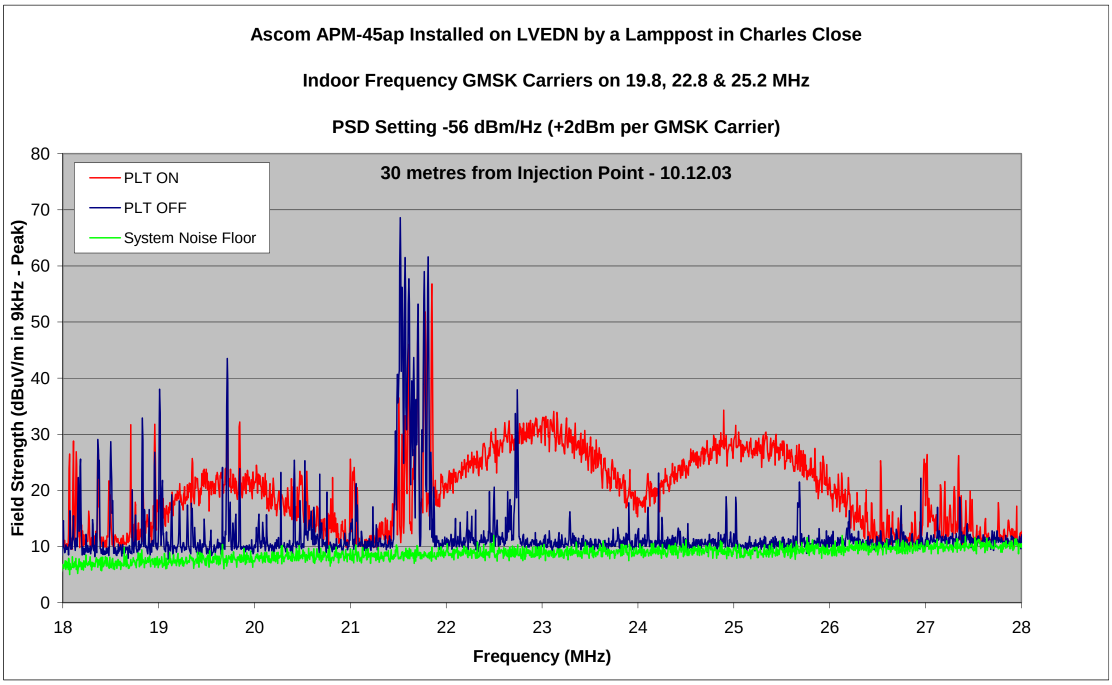
## Radiated at 10 metres

### Figure 26   10 metre leakage emission levels away from Charles Close



## Radiated at 30 metres

### Figure 27 30 metre leakage emission levels away from Charles Close




## Radiated at 100 metres

### Figure 28 100 metre leakage emission levels away from Charles Close

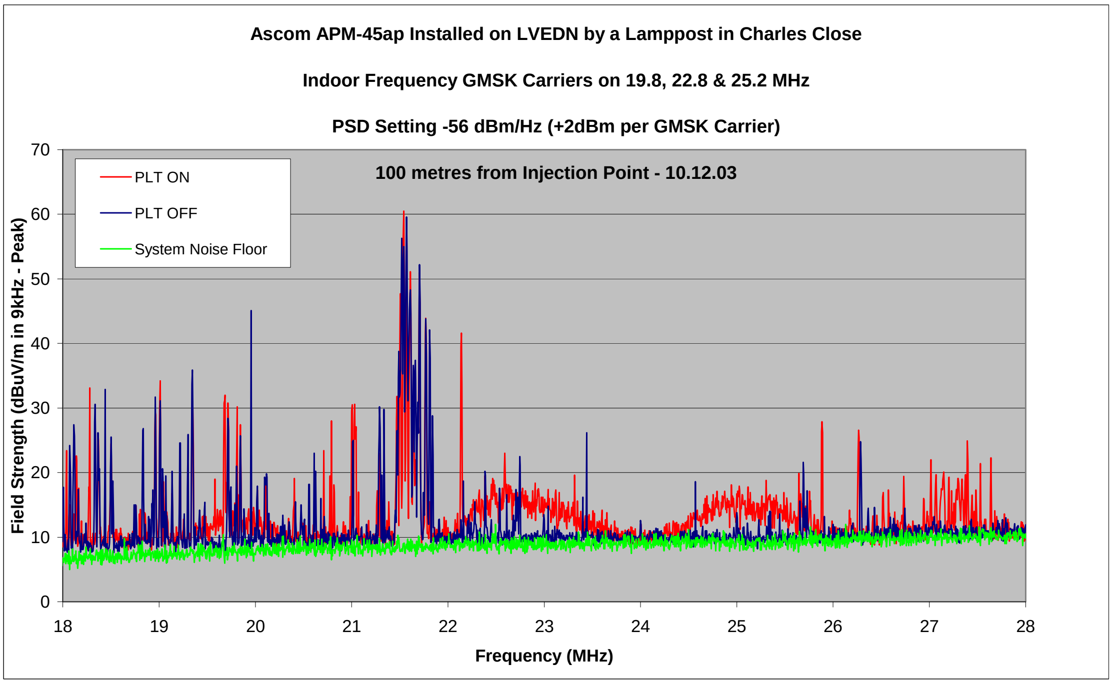


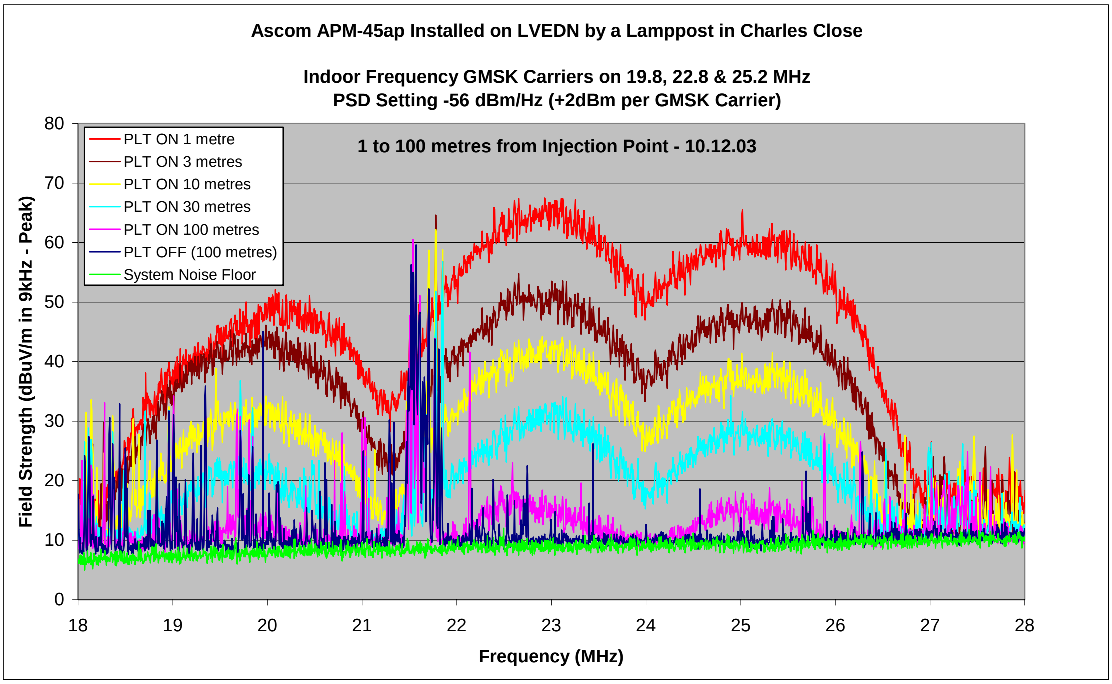
**Figure 29   View from the 100 metre measuring position back to Charles Close**

The launch point is by a lamppost in the background of the picture located midway between the two goal posts shown.

## Access Network Regression Characteristic at Ascom Indoor Frequencies

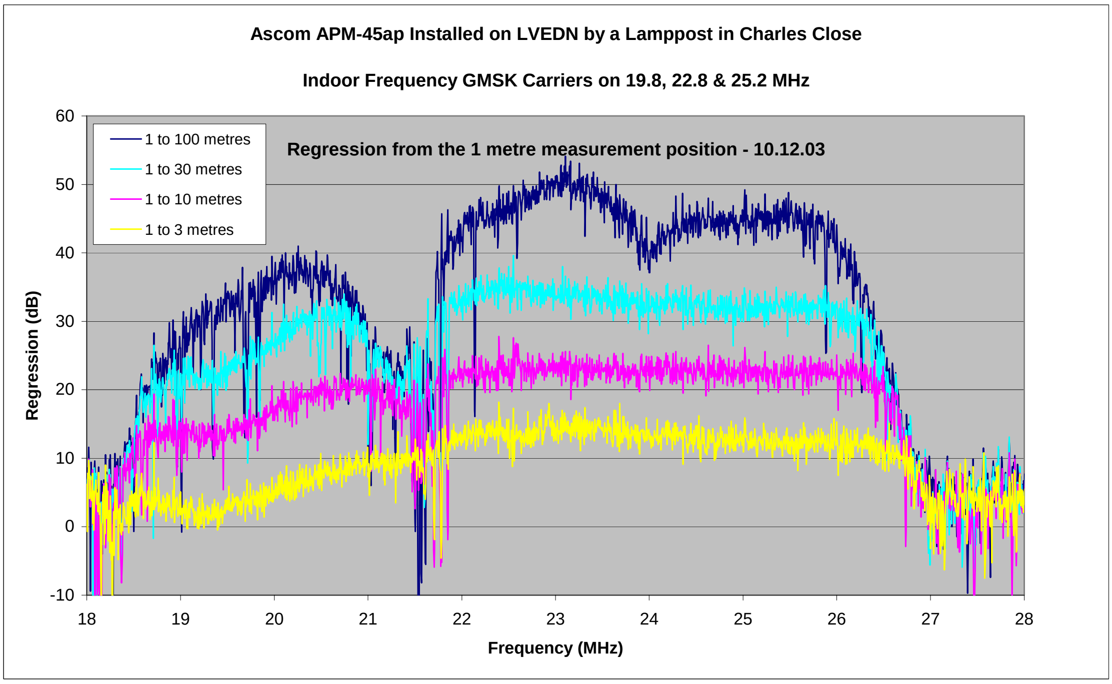
An initial assessment of the field strength regression characteristic was made by combining the 1 to 100 metre field strength measurements on to the chart below.

**Figure 30   1 to 100 metre leakage emission levels away from Charles Close**




The chart has been re-configured below to show the regression characteristic

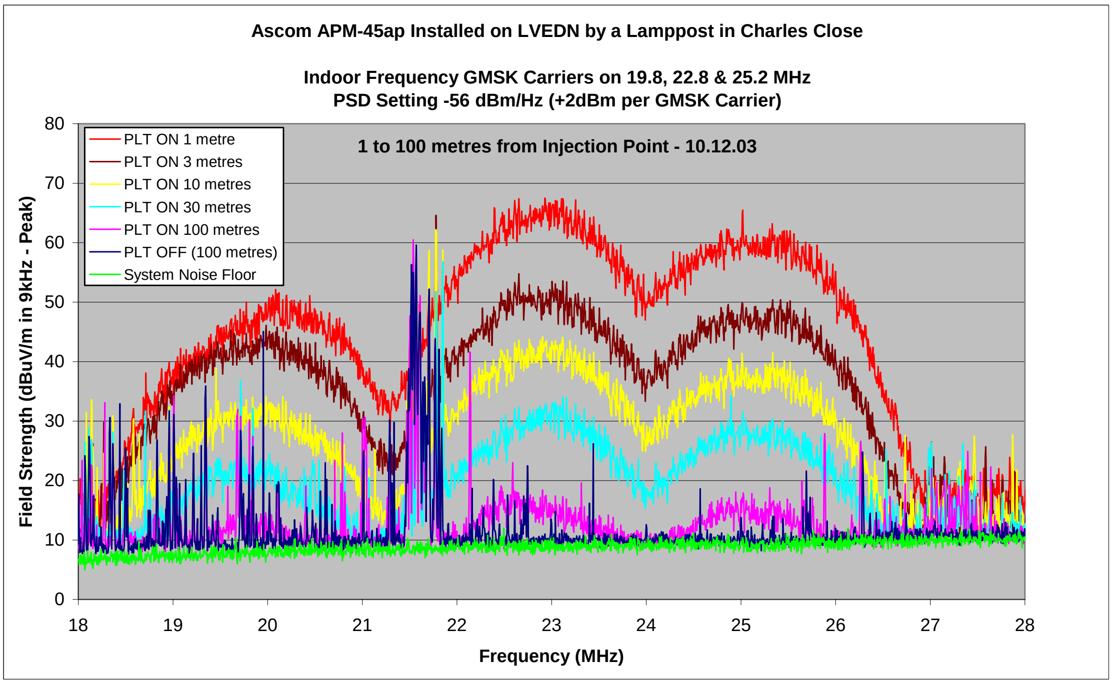
**Figure 31   Regression characteristic of PLT Access Network - Referred to 1 metre**




At 25.2 MHz, the regression characteristic, referred to the1 metre measuring position, is fairly consistent at approximately 23 dB/decade (20 log 1/r^1.15)

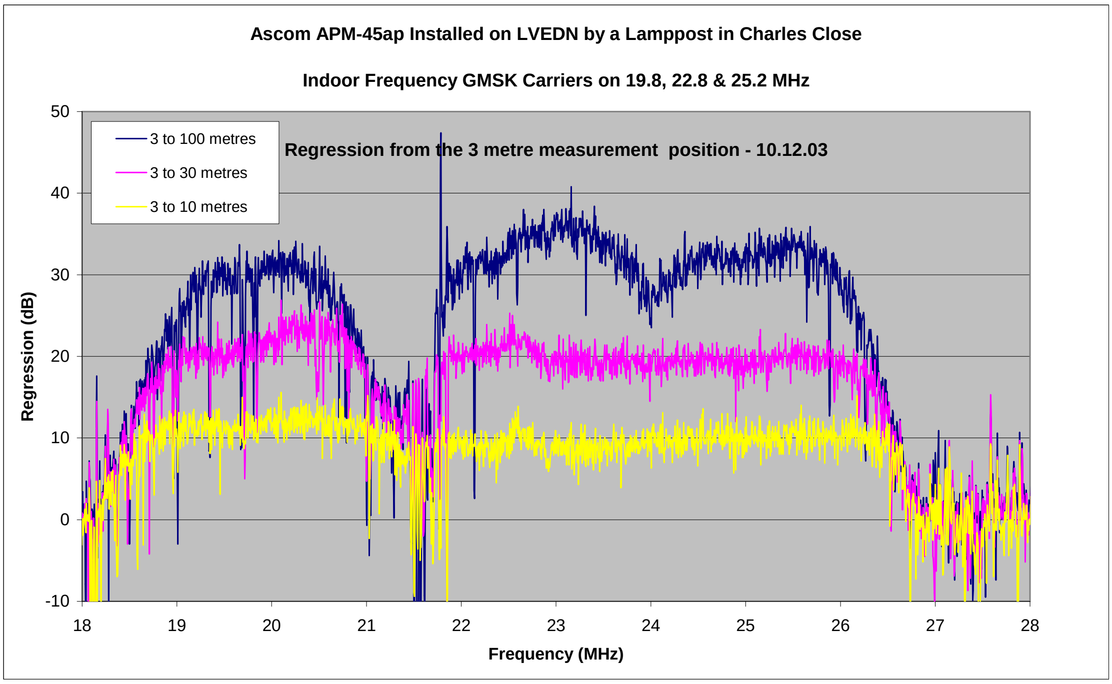
Fig 30 is reproduced again on this page to facilitate comparison with Fig 32 below.

**Figure 30 1 to 100 metre leakage emission levels away from Charles Close**




The chart has been re-configured below to show the regression characteristic

**Figure 32 Regression characteristic of PLT Access Network – from 3 metres**




At 19.8 MHz, it can be seen that the regression characteristic, referred to the 3 metre measuring position, is fairly consistent at approximately 20 dB/decade (20 log 1/r)

Section 6

# Observations and conclusions

## PLT Leakage emission levels

Close correlation was obtained between the 1 and 3 metre leakage emission measurements made on the open field side of the Chaundler Road substation at Winchester in December 2003 and the 1 and 3 metre leakage emission measurements made on the opposite side of the substation in November 2004.

Examination of previous Ascom PLT measurement work in Maidenhead, Crieff and Campbeltown (**Ref.1, 2 & 3**) shows that there is good correlation between the leakage emission level results despite the use of different types of calibrated loop antennas.

As a rough guide, for a launch PSD of -50dBm/Hz, leakage emissions from all the Ascom PLT access networks tested peaked at around 60dBµV/m at 1 metre and 50dBµV/m at 3 metres. All measurements were made in a 9 kHz bandwidth using a peak detector. These levels are consistent with the results of generic PLT leakage emission measurements made during 2001 by RA / RTCG & RA / Baldock for RA's UK Technical Working Group (UKTWG) (**Refs. 6 & 7**)

It is noted, however, that leakage emissions from the Chaundler Road access network measured when the Ascom in-house frequencies were applied to a single phase feeder, as described in section 5.4, were higher than those measured when the Ascom access frequencies were applied to the substation three phase distributors. Compensating for the difference in launch power, the increase noted was between 8 and 19dB. The most likely explanation for this was that the single phase cable was not fed with PLT carriers in a quasi-balanced manner like the 3 phase distributor at the substation.

## PLT Network Regression Characteristics

There has been some argument between the proponents of PLT and regulatory bodies about the regression characteristic of PLT networks but to date there appears to be little evidence of any practical measurements aimed specifically at settling this important issue.

Frequently cited, are textbooks showing that, *for point source radiators*, regression values of 60 dB/ decade (1/r^3) are applicable within the near-field distances commonly used for radiated emission measurements below 30 MHz. This is not particularly helpful as a point source radiator is a theoretical concept that cannot exist in practical form and arguments based on unsupported claims that this value is valid, lead us nowhere.

It is essential to focus on the practical aspects because a large PLT network is obviously not a point source radiator. The way forward is clearly by practical measurement but, as noted in section 4.4, the noise floor of most standard CISPR measuring systems is too high to permit a full analysis.

Lower noise measuring systems, like the one used for this work, are one solution as is the application of higher launch powers achieved, for example, by using broadband Gaussian white noise generators, rather than PLT modems. A combination of both methods is likely to satisfy most experimental requirements and is recommended as a practical way forward for any future regression testing.

The results of the measurements made during the course of this work show that a 20dB/decade regression characteristic was valid in this case.  It is recommended that, during the course of future PLT leakage emission measurements, further work is undertaken to confirm this finding elsewhere.

**Section 7**

# Calibrated equipment list

| DESCRIPTION | MANUFACTURER | Model Number | RTCG Plant |
|---|---|---|---|
| EMI Measuring Receiver | Rohde & Schwarz | ESCS30 | 2832 |
| EMI Measuring Receiver | Rohde & Schwarz | ESCS30 | 2840 |
| EMI Measuring Receiver | Rohde & Schwarz | ESCS30 | 3178 |
| Active Loop Antenna | Rohde & Schwarz | HM525 | Contract |
| Current Clamp | Shaffner Chase | SMZ11 | Contract |

Section 8

# 8.0 References


1. **Ascom PLT installation at S&SE Maidenhead**
RA / RTCG Whyteleafe Report 612 03 September 2002

2. **PLT Measurements at Crieff.**
RA / Baldock Report No. ML2 014/02 25 November 2002
http://www.ofcom.org.uk/static/archive/ra/topics/research/topics/emc/edcrie_2.pdf

3. **PLT Measurements at Campbeltown**
RA / Baldock Report No. ML2-017-03 13 June 2003

4. **The effects of power-line telecommunications on broadcast reception:**
Jonathan Stott and John Salter (BBC R&D)
http://www.bbc.co.uk/rd/pubs/whp/whp067.shtml

5. **'Specification for the Measurement of Disturbance Field from Telecommunication Systems and Networks in the Frequency Range 9 kHz to 3 GHz'**
RegTP 322 MV 05 part 1 October 2001
http://www.regtp.de/en/index.html

6. **The compatibility of VDSL and PLT with radio services in the range 1.6 to 30 MHz**
Report of the UK Technical Working Group Ref. TWG (07) 09 rev 4
October 2002
http://www.ofcom.org.uk/static/archive/ra/topics/interference/documents/twg-finalreport.pdf

7. **Leakage Emissions from ADSL and PLT Networks**
A Presentation to the RRAC annual open forum. November 2003 C Wooff
http://www.ofcom.org.uk/research/industry_market_research/technology_research/rrac/rr_forum2003/?a=87101

**Section 9**

# Acknowledgement

Ofcom would like to thank the management and staff of Scottish & Southern Energy plc for supporting this work.

## Annex A

# List of abbreviations

| ADSL | Asymmetric Digital Subscriber Line |
|---|---|
| BBC | British Broadcasting Corporation |
| BPL | Broadband (over) Power Line (USA) |
| CISPR | International Committee for the study of Radio Interference |
| DTI | Department of Trade & Industry (UK) |
| EMI | Electromagnetic Interference |
| HGW | Home Gateway |
| ISP | Internet Service Provider |
| LV | Low Voltage |
| LVEDN | Low Voltage Electricity Distribution Network |
| NGR | National Grid Reference (Ordnance Survey UK) |
| PLC | Power Line Communications |
| PLT | Power Line Telecommunications |
| PSD | Power Spectral Density |
| RA | Radiocommunications Agency (subsumed into OFCOM UK Jan. 2004) |
| RegTP | Regulator of Telecommunications & Posts (Germany) |
| RTCG | Radio Technology & Compatibility Group |
| SDSL | Symmetrical Digital Subscriber Line |
| S&SE | Scottish & Southern Energy plc (Major UK Power Utility) |
| TDD | Time Division Duplex |
| VDSL | Very High Speed Digital Subscriber Line |